AIRS PERFORMANCE DURING SPACECRAFT THERMAL VACUUM (TVAC) TESTING

Thomas S. Pagano

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Agenda

- **TVAC Accomplishments and Timeline**
- **Performance Results**
  - ***Special Test Results***
- **Summary and Conclusions**

TVAC ACCOMPLISHMENTS AND TIMELINE

TVAC WAS A MAJOR MILESTONE FOR AIRS

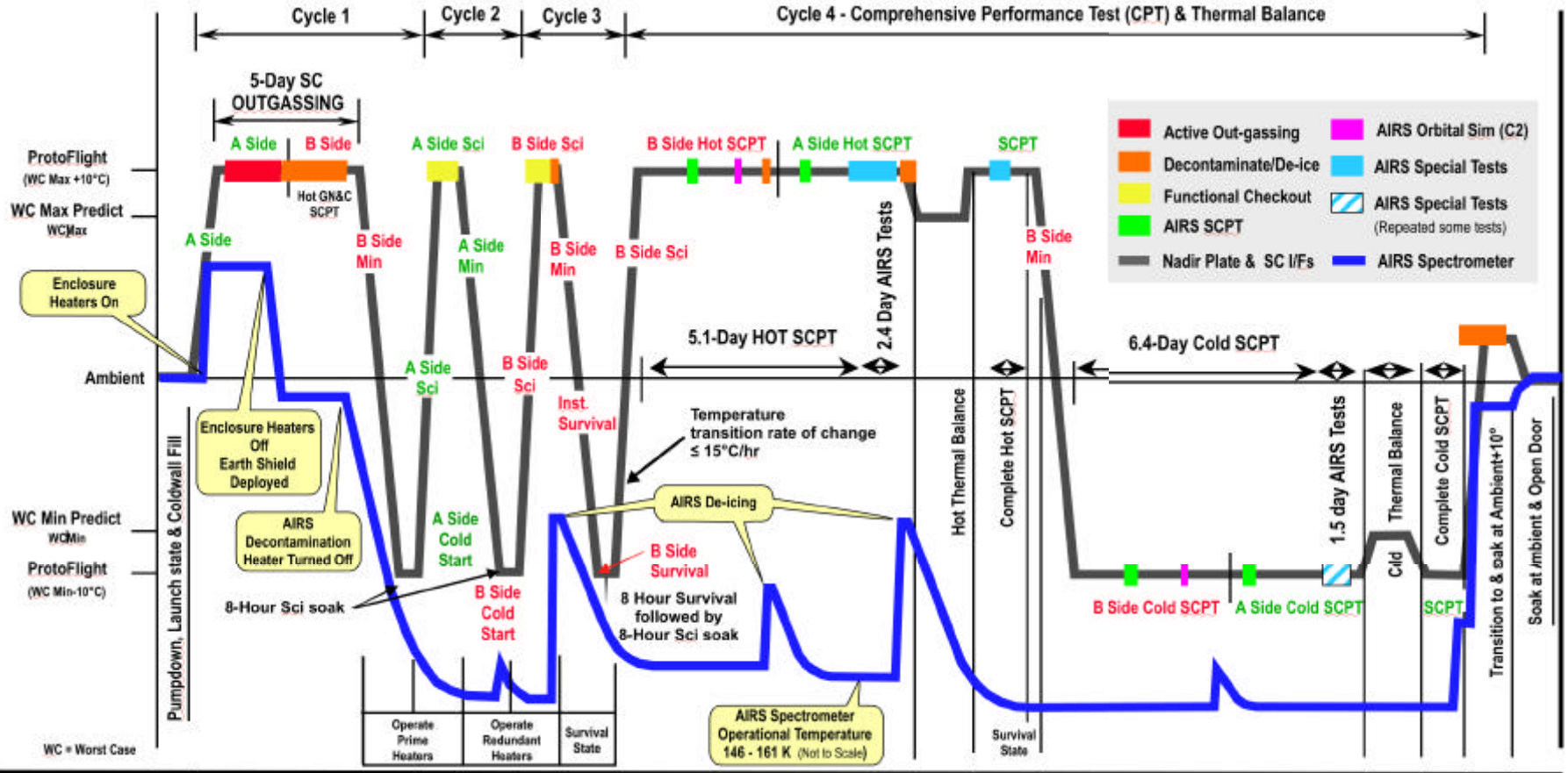
- TRW testing showed no influence from spacecraft or other instruments
- AIRS performed extremely well. No instrument related anomalies detected
- AIRS runs cooler than expected. This means better potentially longer mission life.

THANKS TO THE TVAC TEST TEAM
FOR THE LONG HOURS AND EXCELLENT EFFORT

Your efforts have allowed us to demonstrate that we can successfully operate the AIRS instrument in orbit and characterize its performance!

(SPECIAL THANKS TO THE MANY OTHERS WHO CONTRIBUTED BUT WERE NOT ABLE TO MAKE THE PHOTO)

THERMAL VACUUM TESTING AT TRW TOOK ALMOST 47 DAYS



Test Phase	1&2	3	4	5	6	7	8	9A	10	9B	11A	12	11B	13	14
Days per phase	1.1	6.3	1.4	0.9	1.5	0.9	1.8	9.1	2.0	3.2	12.0	2.0	2.5	1.0	1.0
Cummulative Days	1.1	7.4	8.8	9.7	11.2	12.1	13.9	23.0	25.0	27.2	39.2	41.2	44.7	45.7	46.7

AIRS TVAC ACCOMPLISHMENTS

- ***AIRS instrument and all subsystems performed extremely well***
- ***Accomplishments include:***
  - Earth Shield deployed as commanded
  - Detector dewar vacuum integrity test verified no change from BAE tests
  - Coolers work very efficiently and reliably for long periods of time when left undisturbed.
  - Scanner can be started and operated at a lower temperature
  - Focal plane is fully operational and shows gain ratios equivalent to BAE test data
  - AMA can be commanded to known position and works as expected
  - Spectrometer thermal control can be maintained with high stability
  - Performance sensitivity to thermal state (nominal temp and gradients) characterized
  - The AIRS spectrometer can be maintained at a lower temperature set point
  - AIRS operation procedures work as designed
  - Special Calibration Tests work as designed
- ***CONCERNS / LIENS***
  - On-orbit outgassing plan and timeline needs to be reviewed to prevent ice formation on foreoptics
  - Spacecraft initiated time jams cause major disruptions to the normal operation of AIRS.
  - AIRS on-orbit thermal model must be updated based on the new thermal data set

AIRS INSTRUMENT PERFORMANCE RESULTS

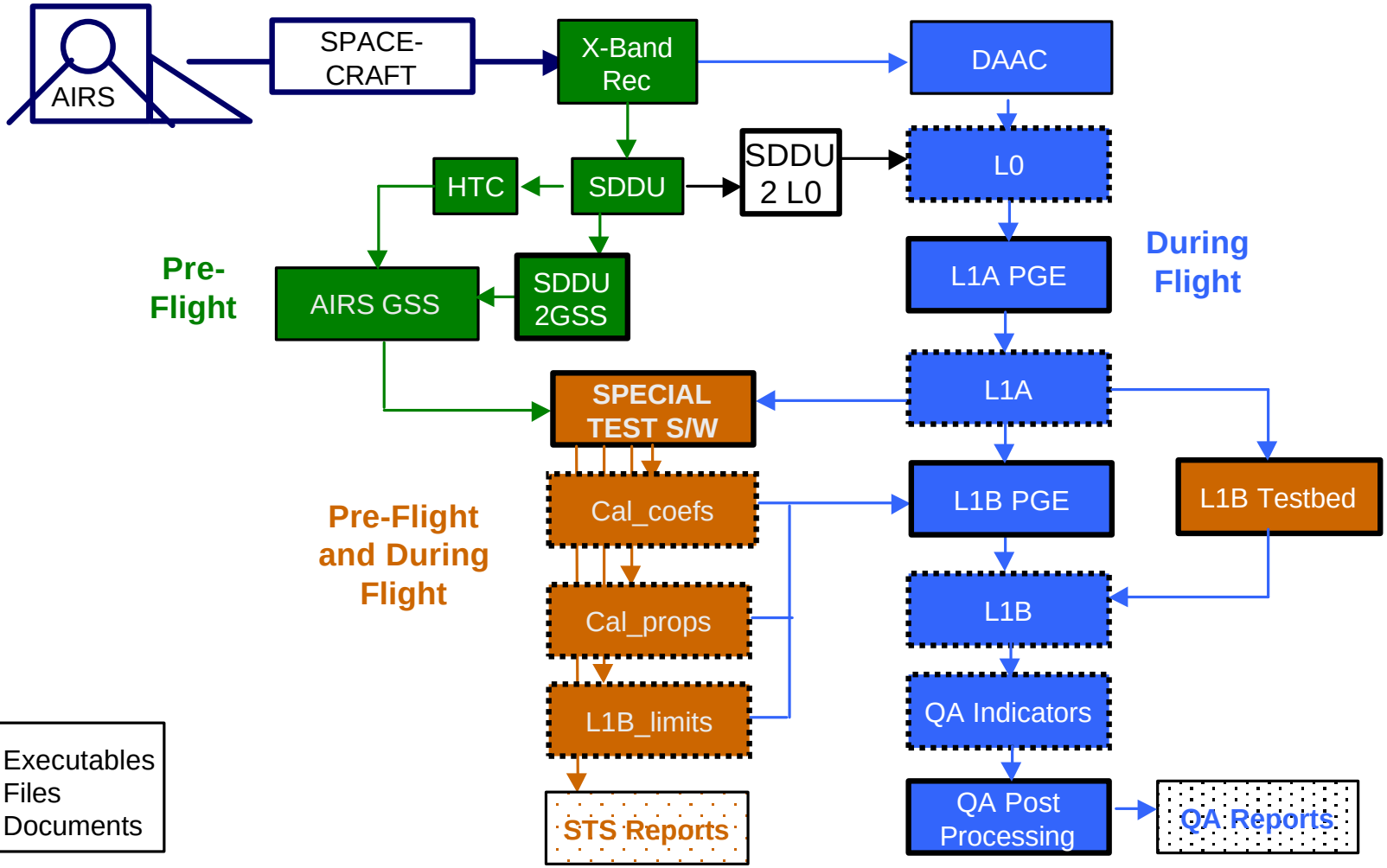
SPECIAL CALIBRATION TEST SEQUENCES (STS) A KEY ELEMENT OF IN-FLIGHT CAL PLAN

- **Transfer pre-flight calibration to in-orbit configuration**
  - Same tests performed pre-flight at TRW and in-orbit
  - Tests are traceable to pre-flight calibration using NIST traceable sources
  - Check location of spectral response functions
  - Re-establish instrument linear radiometric response
- **Discover and quantify potential new sources of stray light and noise**
  - Stray light in the space viewport
  - Determine orbital dependence of noise
  - Set Radiation Circumvention Levels
- **Correct for launch environmental changes**
  - Adjust AMA for AB Balance and Spectral Centering

TWELVE SPECIAL TEST OBTAIN KEY MEASUREMENTS

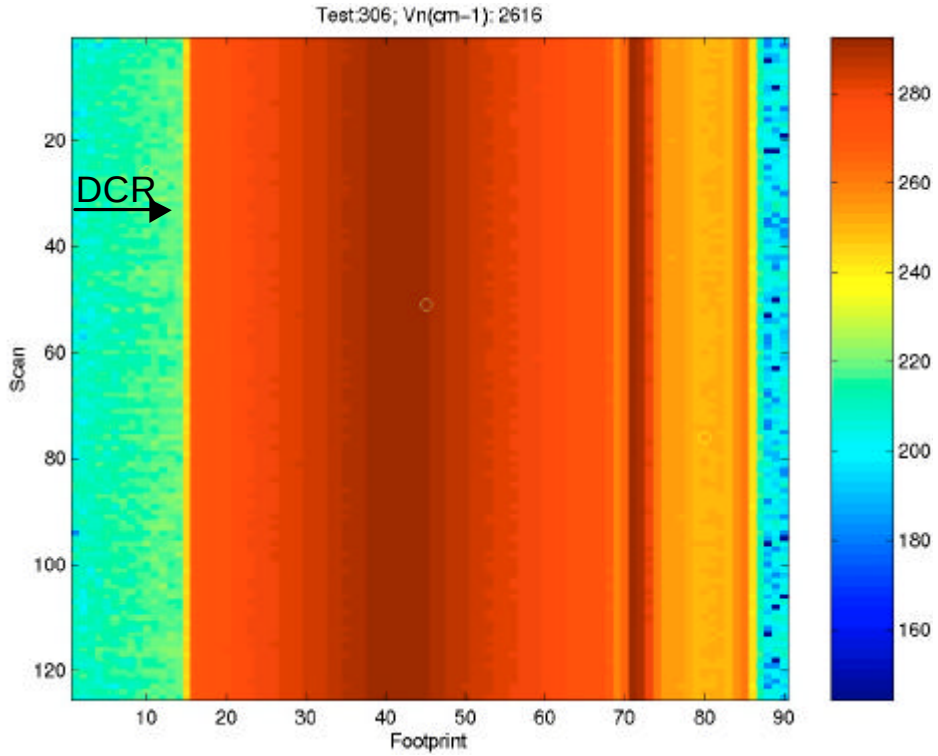
Test ID	Name	Description	Measurement Obtained
AIRS-C1	Normal Mode / Special Events	Establish normal DCR and Lamp operation. Flag data for special events Earth Scene targets of opportunity.	Focal Plane Model Geolocation SST Acquisitions
AIRS-C2	Guard Test	Cycles through A, B and A/B Optimum Gains and acquires data.	Radiometric Gains NEdT Spectral FP Model (Parylene)
AIRS-C3	Channel Spectra Phase	Heat and cool spectrometer by ±1K	Phase of Channel Spectra
AIRS-C4	AMA Adjust	AMA is moved to the desired x (spatial) and y (spectral) position.	AB Balance Spectral Adjust
AIRS-C5	OBC Cool	Blackbody heater is turned off	IR Linearity
AIRS-C6	Variable Integration Time	Integration time is varied on readout while scanning	Electronics Linearity
AIRS-C7	Space View Noise	The scan mirror is stopped and parked at OBCs	Noise Behavior (Pops, FPN, etc) Drift Characterization
AIRS-C8	Radiation Circumvention	Same test as AIRS-C7 but with radiation circumvention turned on.	Threshold Levels
AIRS-C9	Scan Profile	Slow part of scan rotated to OBCs	Stray Light Calibrator Centration
AIRS-C10	Lamp Operations	Each of the three lamps are exercised by user command.	VIS Gains, VIS Noise
AIRS-C11	Warm Functional	Focal Plane Power is Cycled Test Pattern Gain Table Loaded	FPA Functionality Data Stream Verification
AIRS-C12	Cold Functional	Same as AIRS-C11 except performed cold.	FPA Functionality

MANY PATHS USED TO OBTAIN CAL DATA PRE-FLIGHT AND DURING FLIGHT

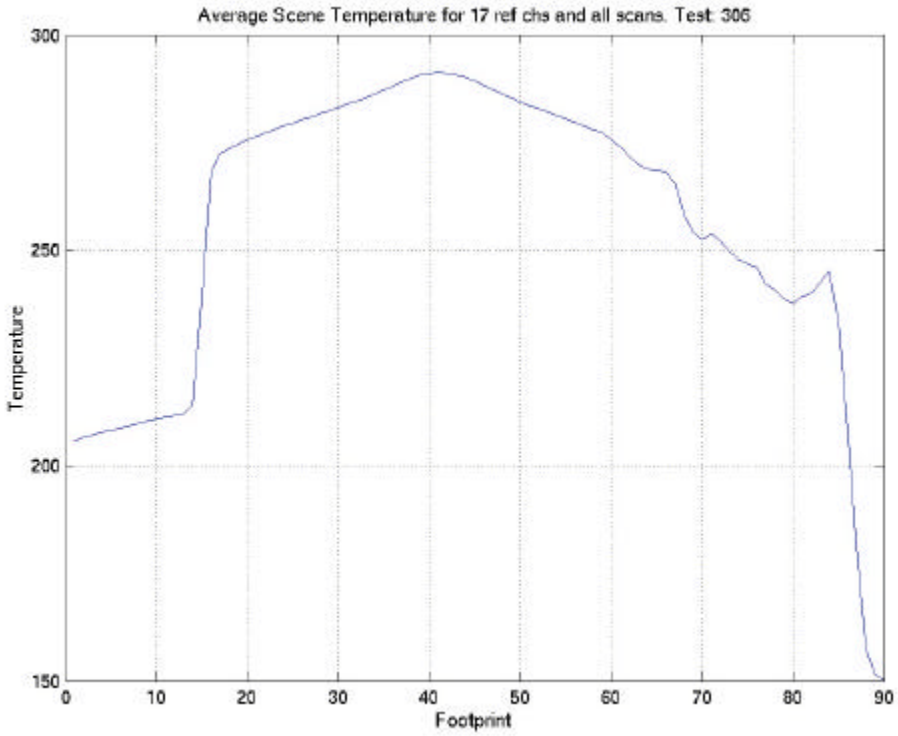


C1: NORMAL MODE
IMAGERY OF NADIR PANEL LOOKS GOOD

AIRS THERMAL IMAGE*



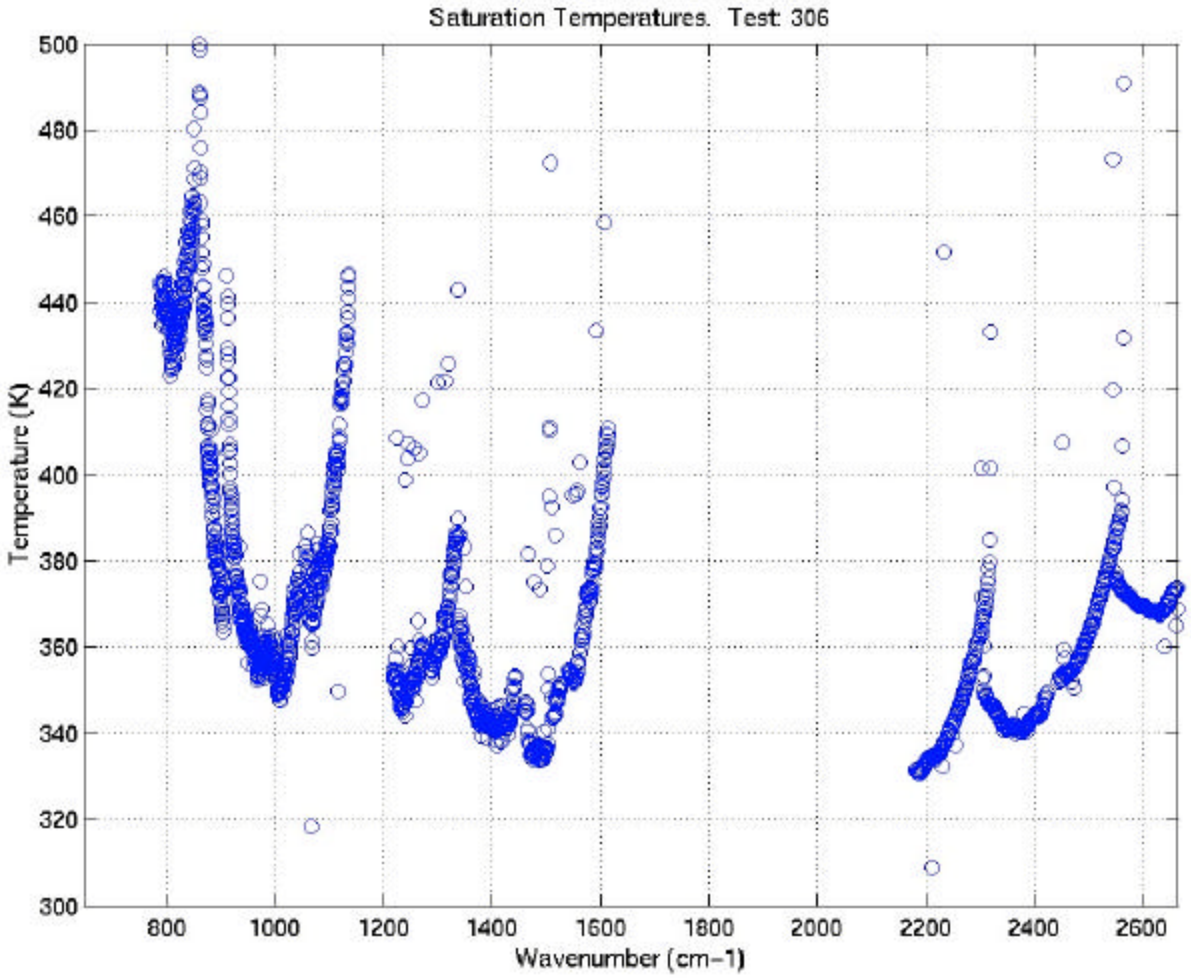
NADIR PANEL TEMPERATURE



- **C1 TEST USED TO EXPEDITE DATA AND INITIATE DCR AND PERIODIC LAMP OPERATIONS**
- **TVAC VERIFIED PROPER OPERATION**

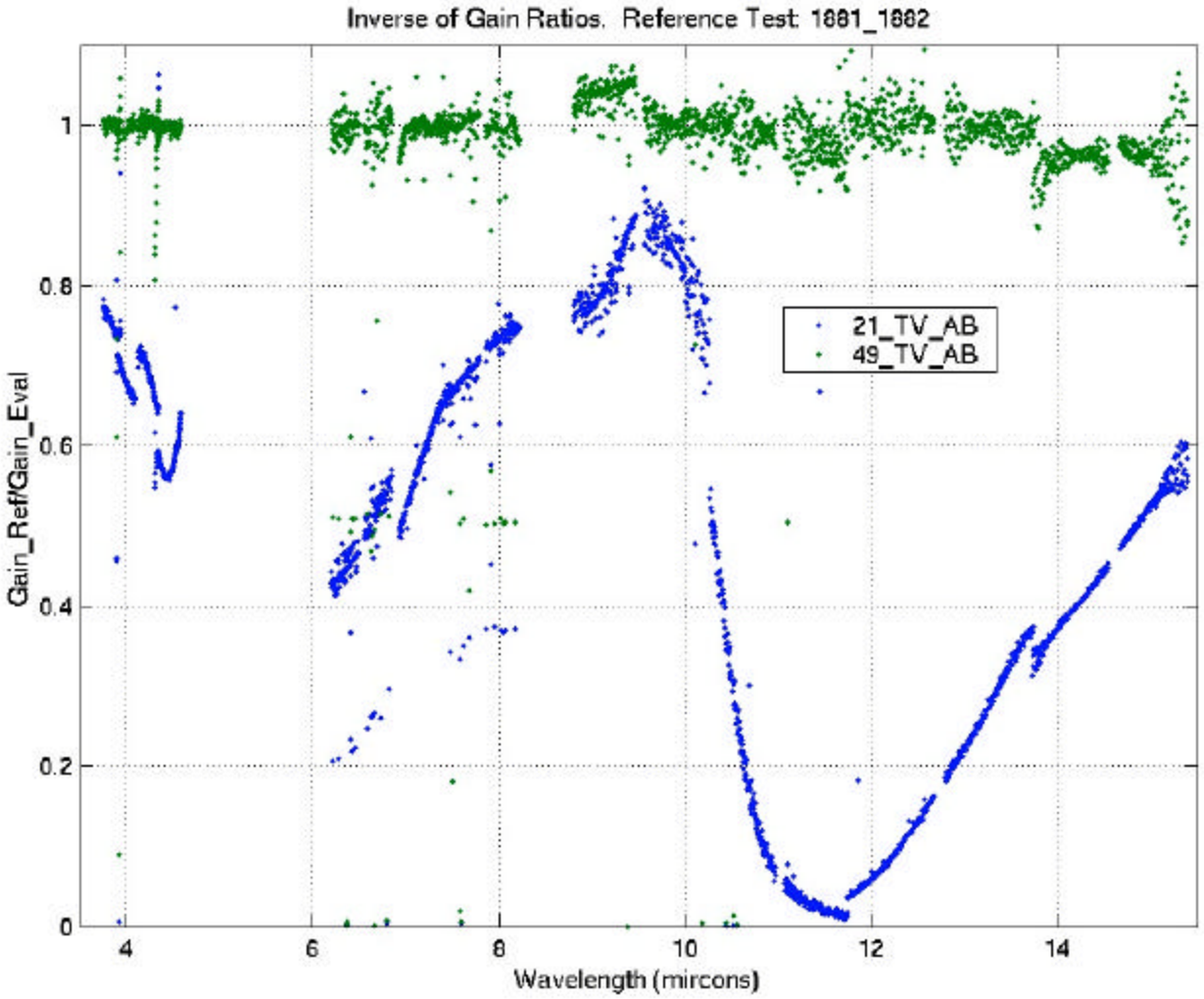
***Small circles identify places where software displays spectra. Please ignore.**

C1: PREDICTED SATURATION LEVELS COMPUTED BASED ON A/D SATURATION



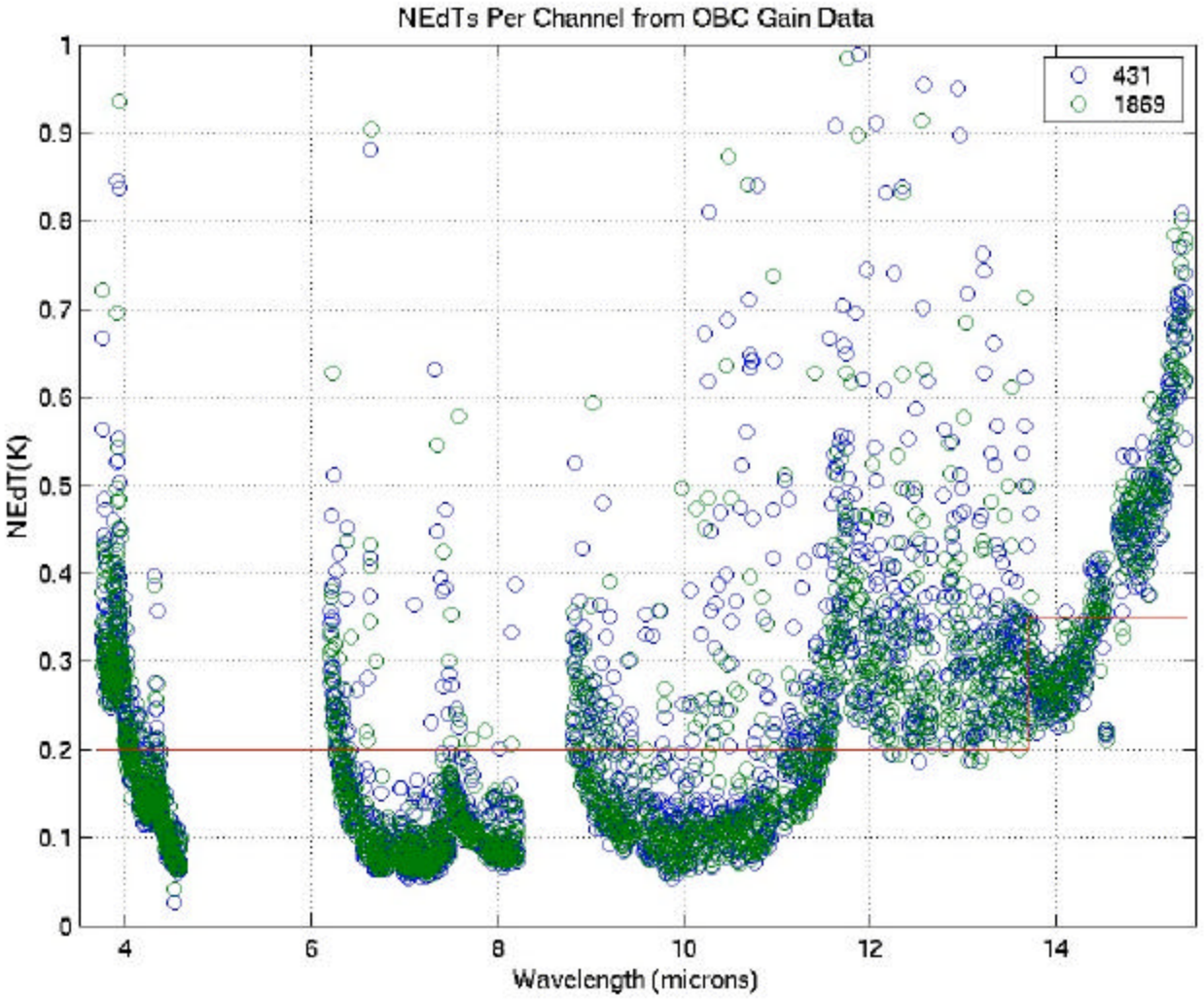
M1 AND M2 DETECTORS MAY SATURATE PRIOR TO A/D SATURATION

C2: FIRST OBSERVATIONS OF GAINS IN TVAC SHOWED ICING OF OPTICS



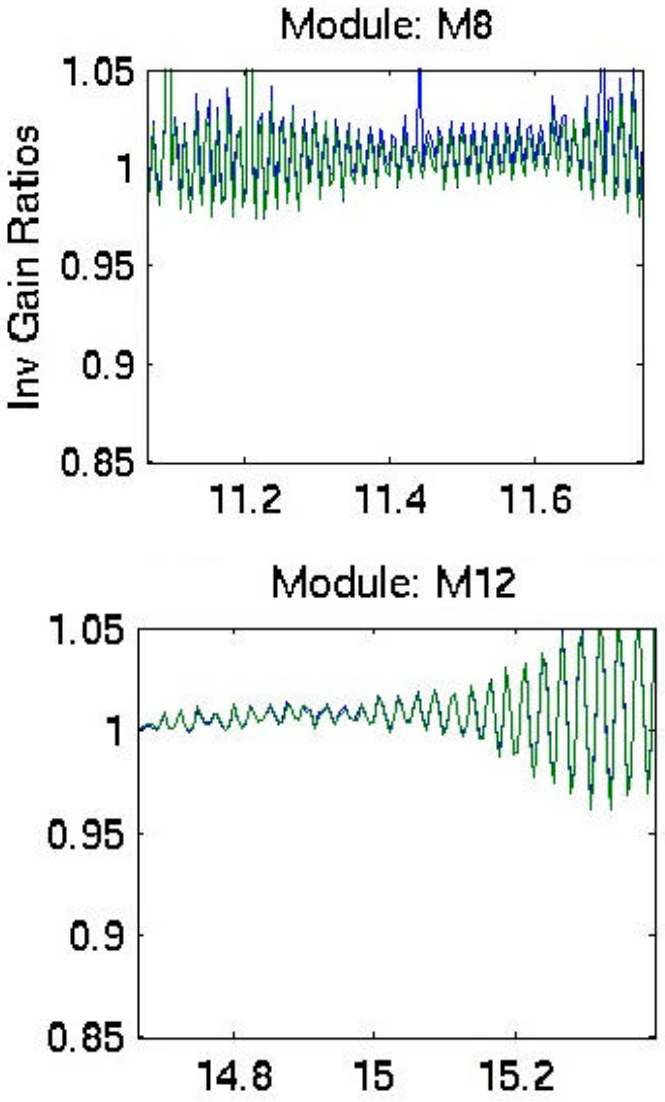
- **ICE GONE AFTER OUTGASSING**
- **REQUIRED ELEVATED TEMP OPERATION UNTIL ICE DISSIPATED**
- **ICE TRANSMISSION SPECTRUM**

C2: NEDTs COMPARABLE WITH THOSE TAKEN AT BAE SYSTEMS



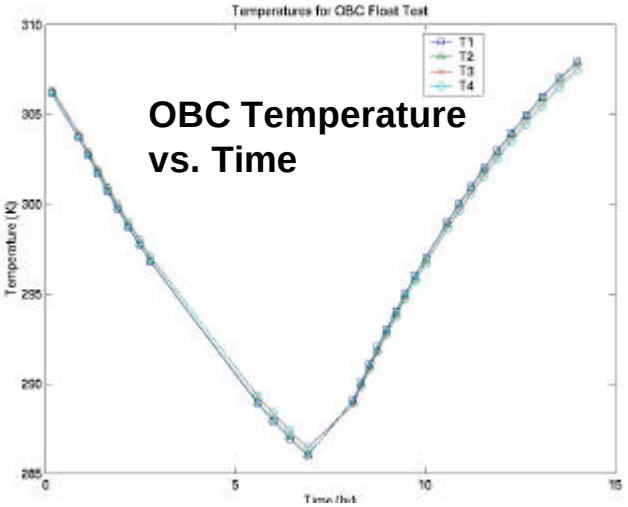
C3: EXCELLENT GAIN STABILITY AND FIDELITY ALLOW CHANNEL SPECTRA PHASE DETERMINATION

WORK IN PROGRESS

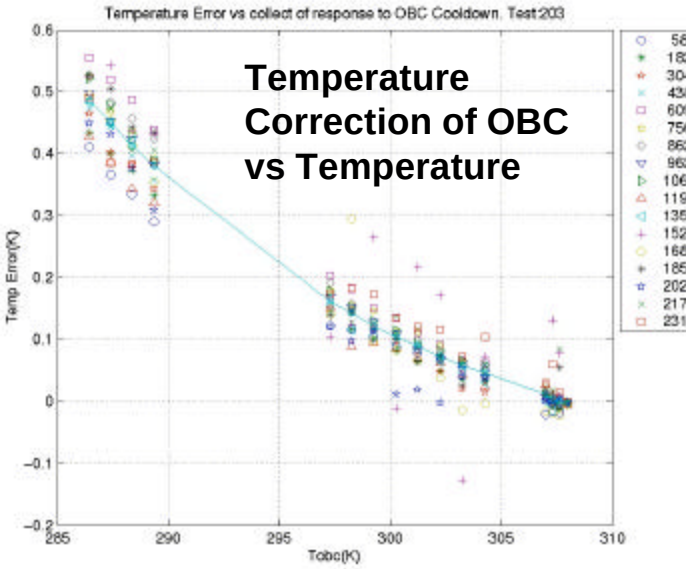


Oscillations due to channel spectra phase change with optics temperature (appx 3° here)

C5: OBC FLOAT TEST PROVES ABILITY TO MEASURE ON-ORBIT NONLINEARITY

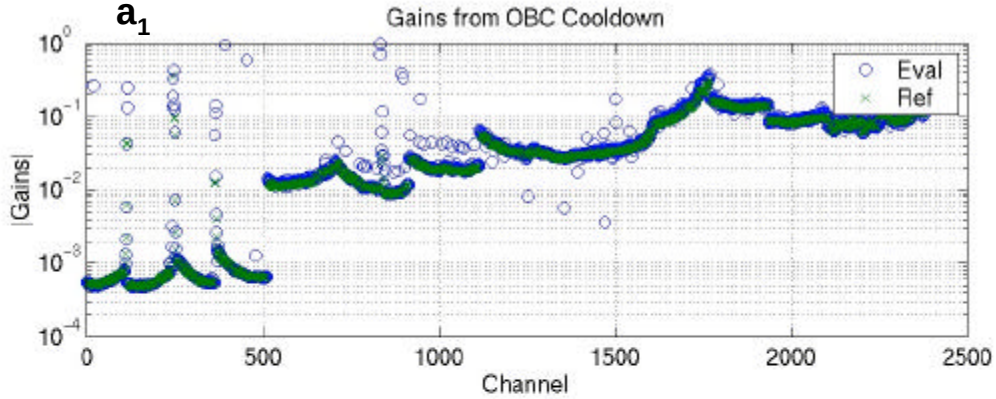


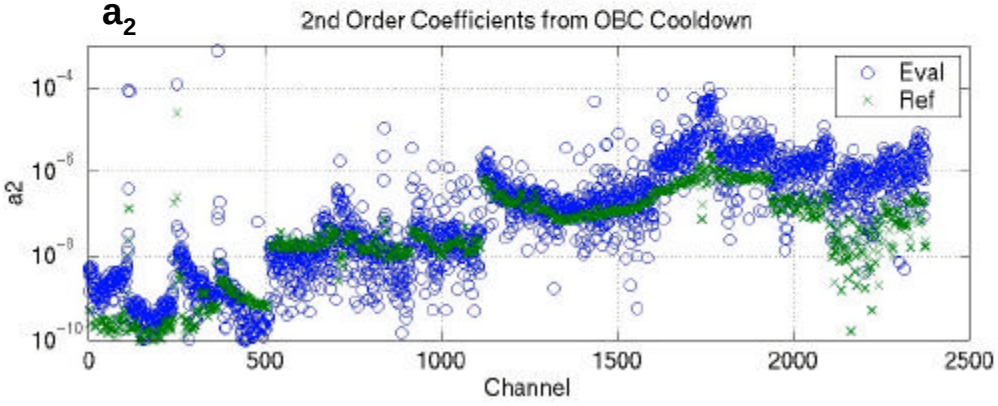
OBC Temperature vs. Time



Temperature Correction of OBC vs Temperature

OBC FLOAT TEST CONFIRMS RADIOMETRIC CALIBRATION COEFFICIENTS ON ORBIT

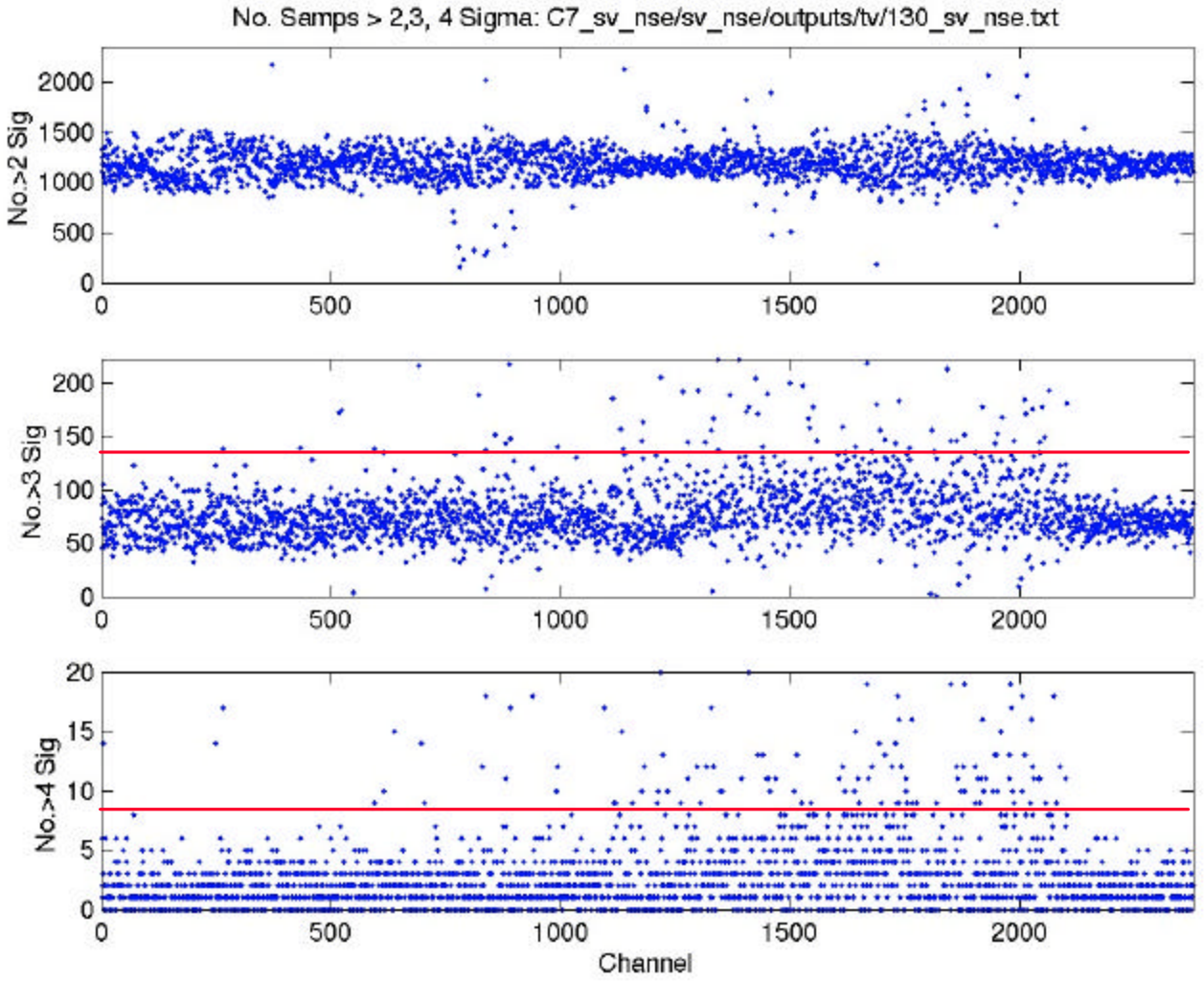




C6: USES VARIABLE INTEGRATION TIME AND ALSO CHECKS NONLINEARITY

C7: SHOWS MOST DETECTORS HAVE GAUSSIAN NOISE

STARE AT SPACE OR OBC AND COLLECT NOISE SAMPLES



NO FIXED PATTERN NOISE OBSERVED

>25,000 NOISE SAMPLES ACQUIRED

NUMBER OF EVENTS > 2, 3, 4 SIGMA COUNTED

THRESHOLDS DEFINED TO SELECT A AND B DETECTORS

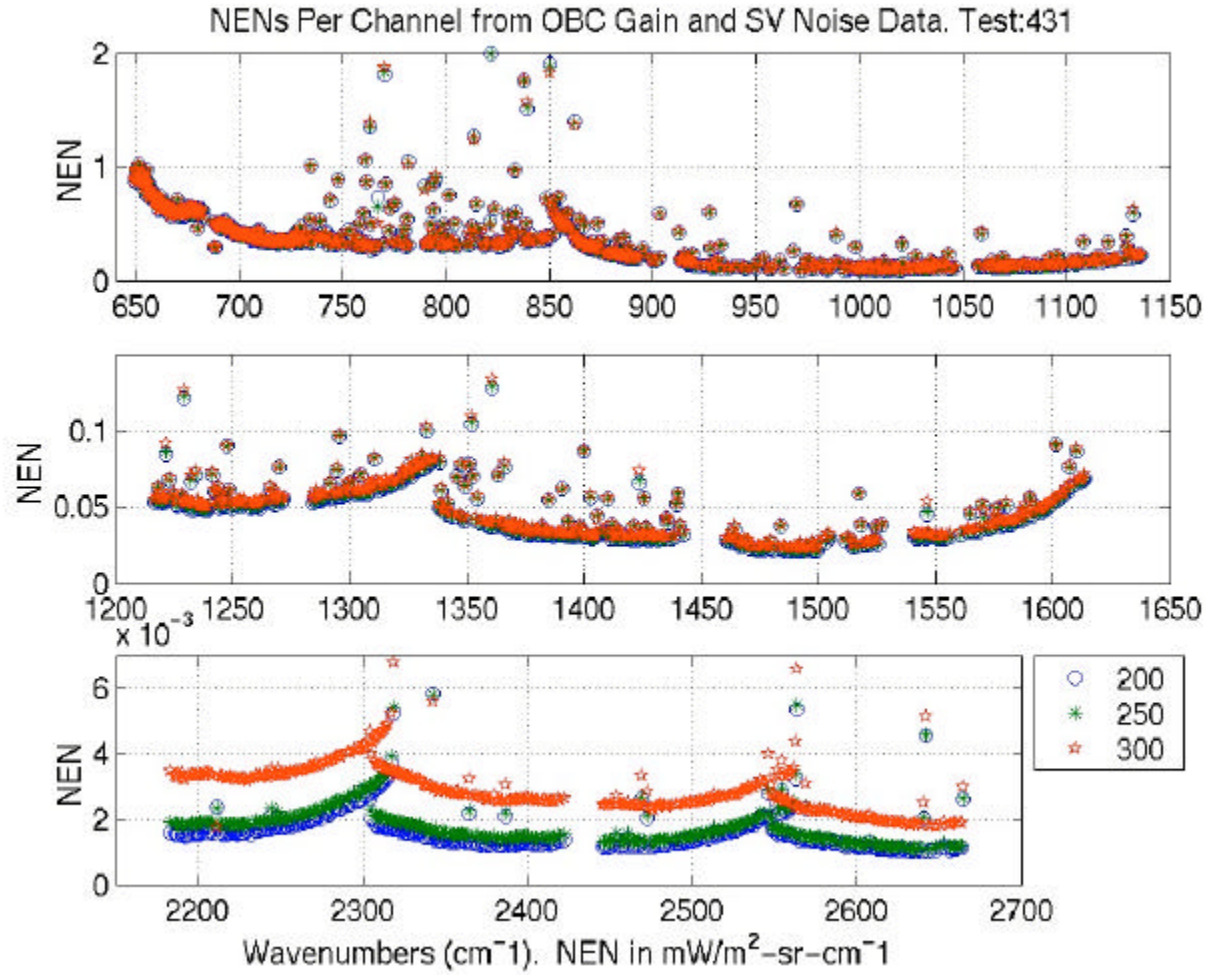
C7: SOME SCENE DEPENDENCE OF NENS FOR M1 AND M2

Noise data acquired staring at OBC and SV independently give signal dependence on noise

Detector Noise Limited M5-M12

Detector Noise Limited M3, M4

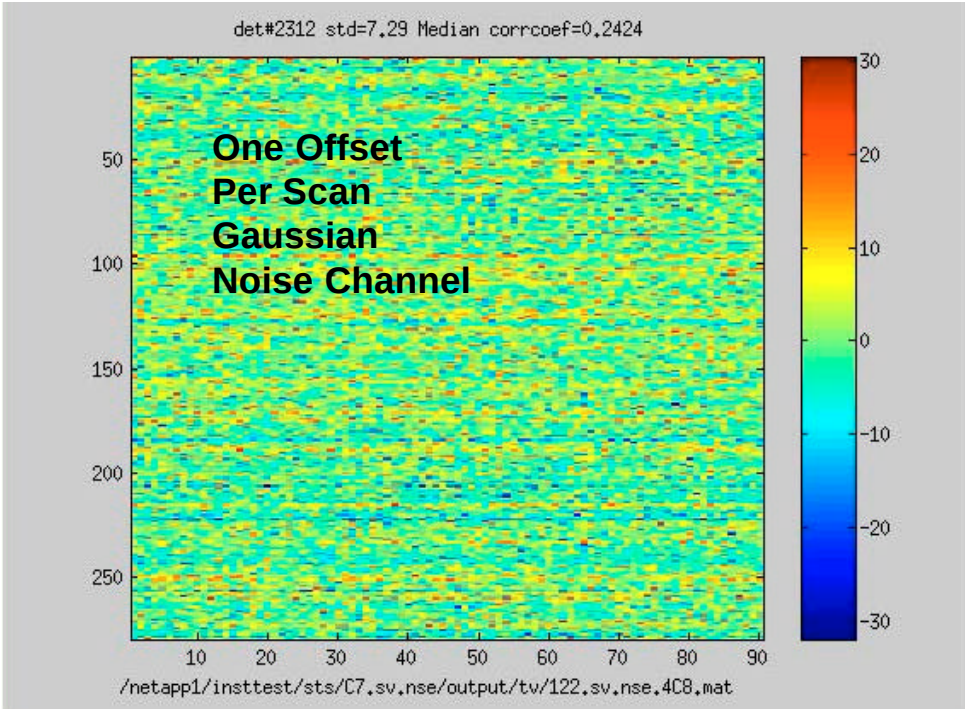
Photon Noise Limited M1, M2

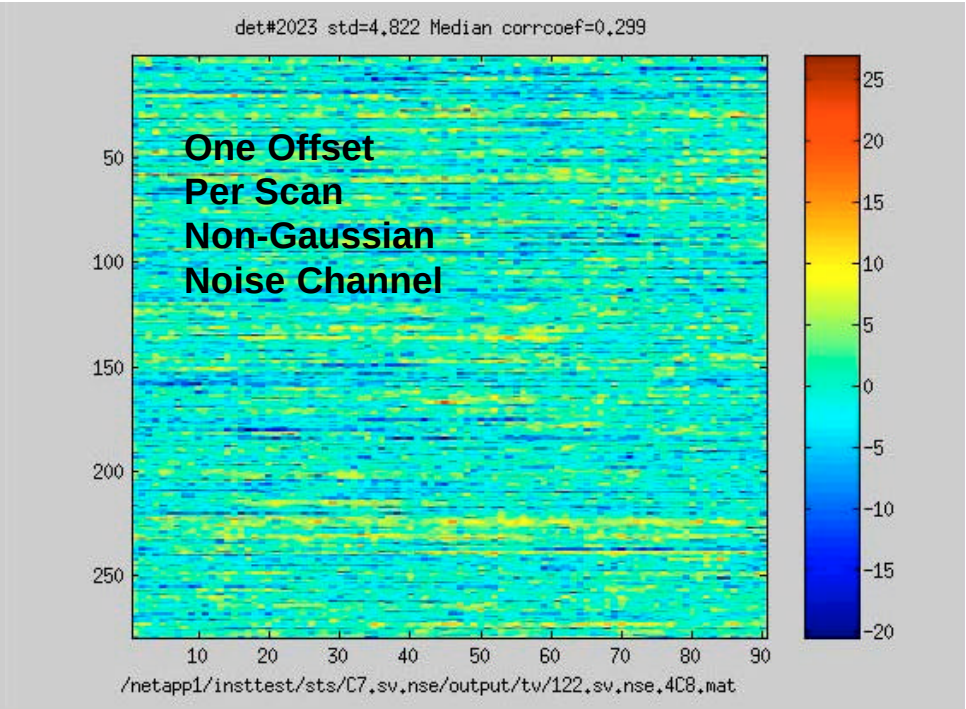


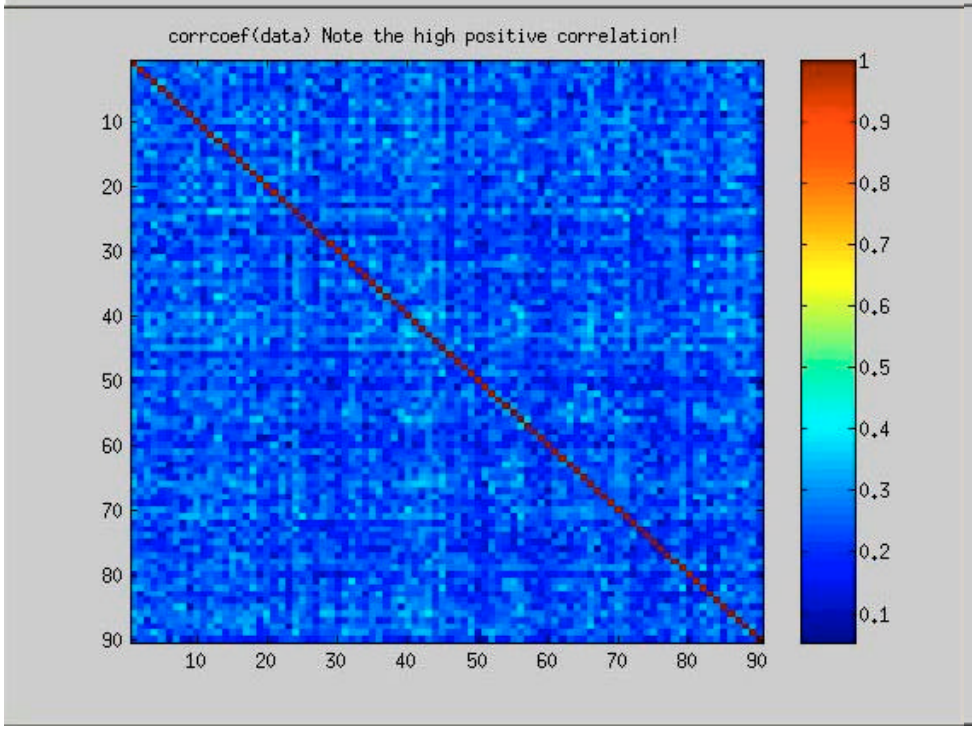
SV SUBTACTION TECHNIQUE AFFECTS SCENE CORRELATION ERROR

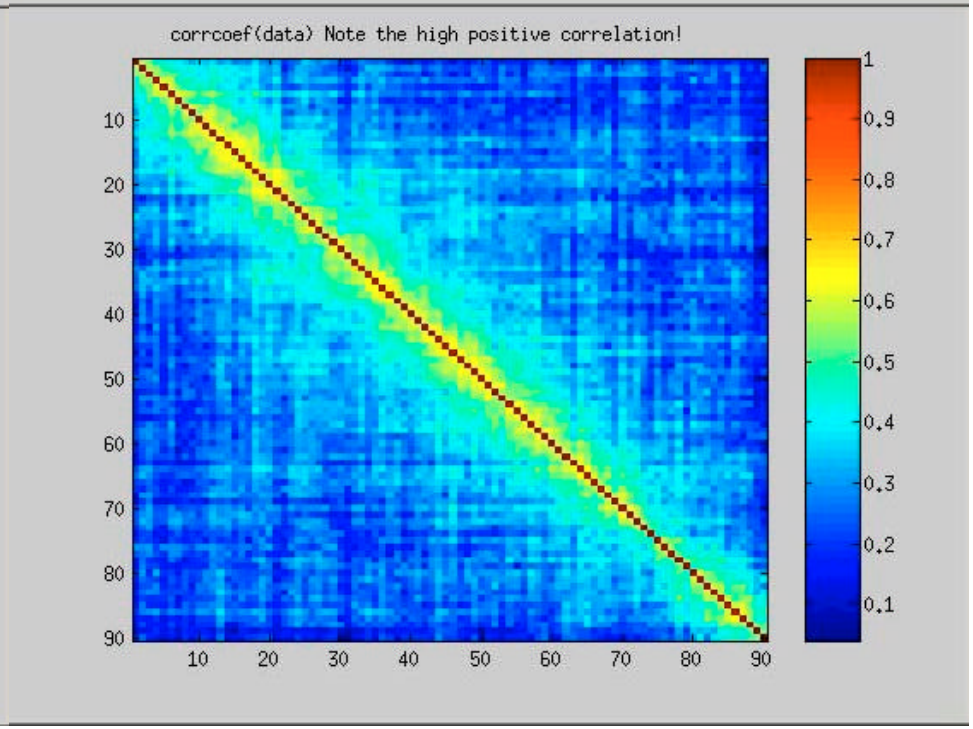
- **At-launch technique**
  - ***Subtacts median of 8 space views (offset) per scan line from all footprints in the scan line.***
  - ***A new offset is calculated for each scan line***
  - ***Results in more noise along track than along scan because all footprints use same space view offset***

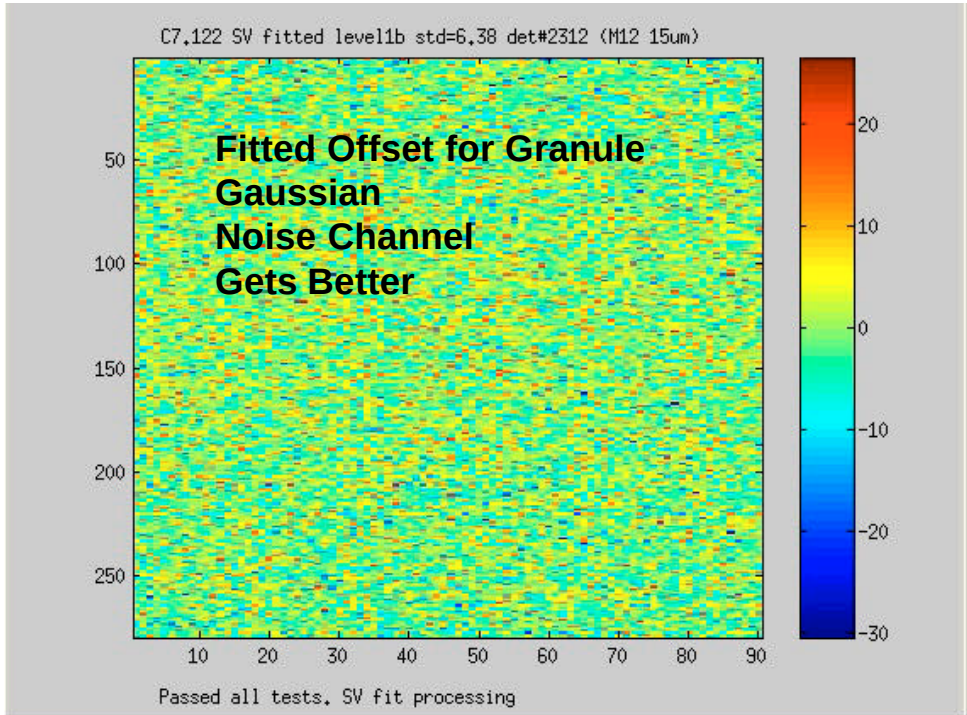
- **Alternate technique**
  - ***Offset calculated as fit to offset for all scans in the granule***
  - ***All scans share a common space view functional dependence***
  - ***Results in lower noise correlation error for well behaved detectors***
  - ***Expect difficulties when we have DCR or moon in the viewport***
  - ***Increases the noise for channels with higher 1/f noise***

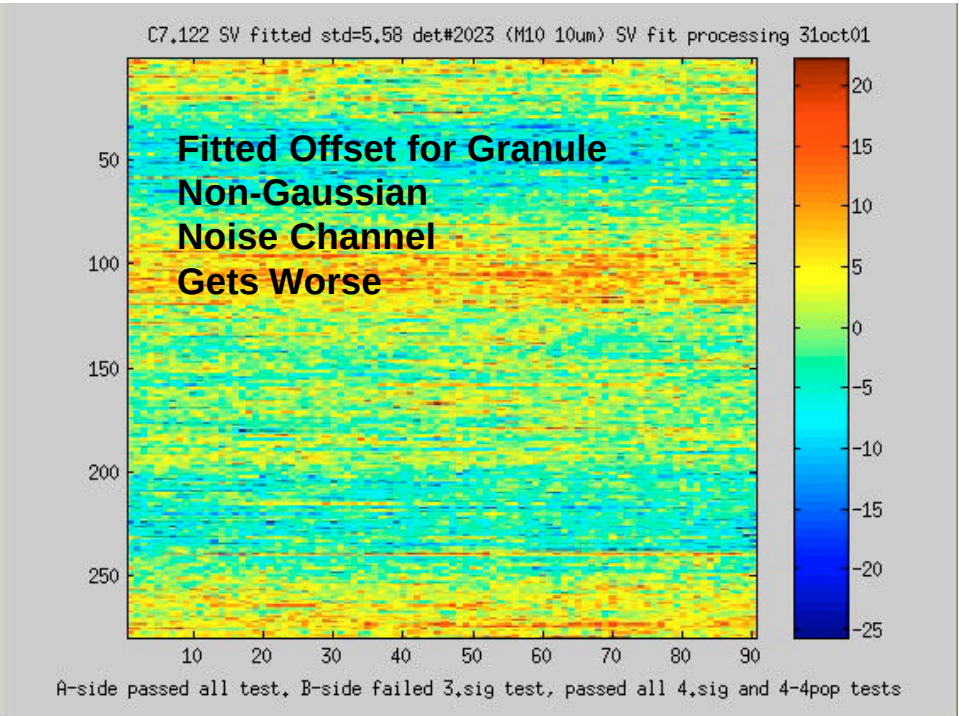

det#2312 std=7.29 Median corrcoef=0.2424
One Offset
Per Scan
Gaussian
Noise Channel
/netapp1/insttest/sts/C7.sv.nse/output/tv/122.sv.nse.4C8.mat

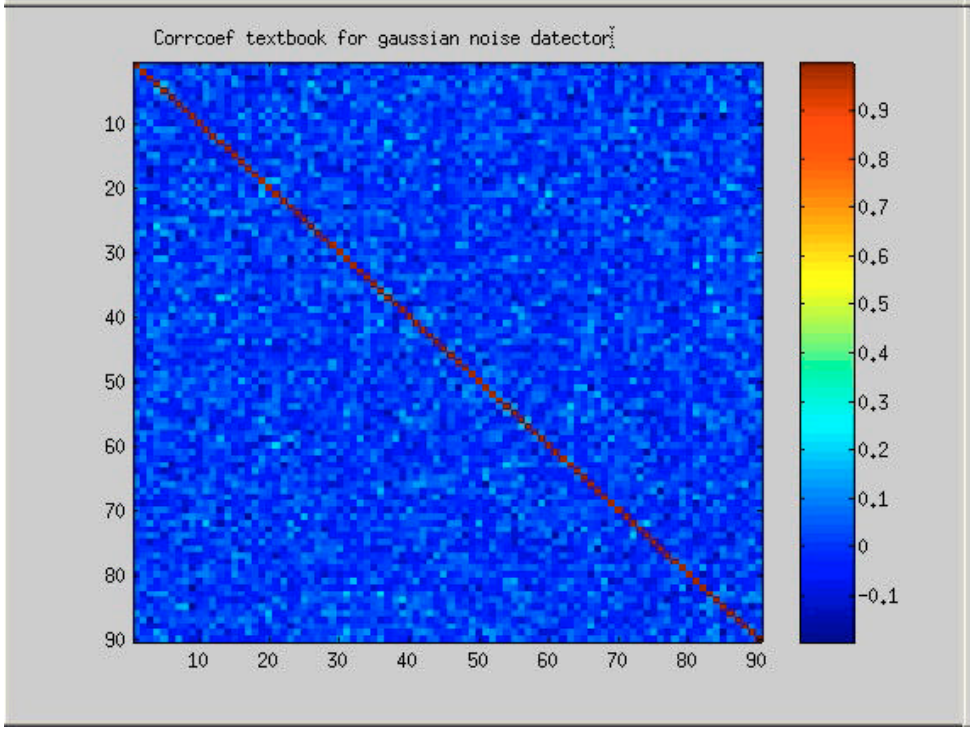

det#2023 std=4.822 Median corrcoef=0.299
One Offset
Per Scan
Non-Gaussian
Noise Channel
/netapp1/insttest/sts/C7.sv.nse/output/tv/122.sv.nse.4C8.mat

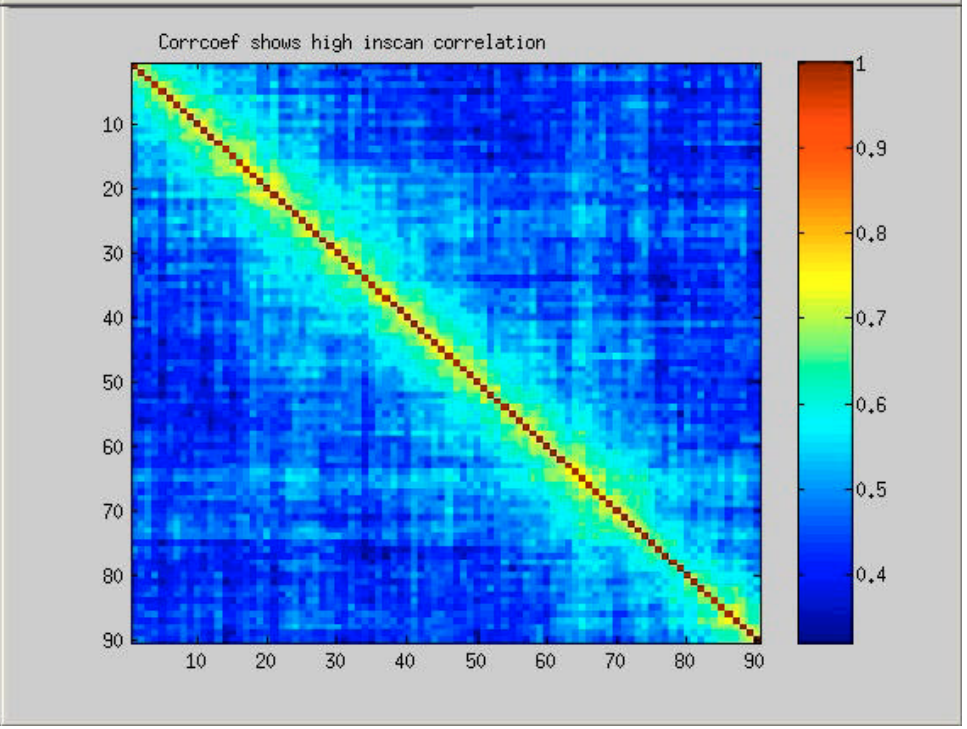

corrcoef(data) Note the high positive correlation!


corrcoef(data) Note the high positive correlation!


C7.122 SV fitted level1b std=6.38 det#2312 (M12 15um)
Fitted Offset for Granule
Gaussian
Noise Channel
Gets Better
Passed all tests. SV fit processing


C7.122 SV fitted std=5.58 det#2023 (M10 10um) SV fit processing 31oct01
Fitted Offset for Granule
Non-Gaussian
Noise Channel
Gets Worse
A-side passed all test. B-side failed 3.sig test, passed all 4.sig and 4-4pop tests


Corrcoef textbook for gaussian noise datector


Corrcoef shows high inscan correlation

C8, C9, C10 SPECIAL TESTS RESULTS

- **C8: Radiation Circumvention Test**
  - ***Acquired thresholds for one channel per module***
  - ***Should be adequate to set levels for all channels***
  - ***Requires final setting in orbit in radiation environment***
- **C9: Scan Profile Test**
  - ***Rotated scan profile allows us to measure stray light on on-board calibrators***
  - ***Test run successfully and data show no anomalies***
- **C10: Vis/NIR Lamps**
  - ***Lamps worked well. Vis/NIR responses as expected***
  - ***Longer than expected turn on transients require longer wait time after lamp turn on prior to calibration***

SUMMARY AND CONCLUSIONS

- **The AIRS instrument performed exceptionally well in T/V**
- **No problems encountered with AIRS instrument**
- **We learned a tremendous amount about the instrument**
  - ***Temperature stability requirements***
  - ***Noise behavior***
  - ***Alignment methods (AMA)***
  - ***Spectral and Radiometric Sensitivity***
  - ***Techniques for characterization of performance in orbit***
  - ***Some test procedures need modification***
- **Special Test Procedures will be performed again during A&E phase and will allow traceability of performance from pre-flight to in-orbit**